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OF THE

ASSOCIATION

OF

PACIFIC COAST GEOGRAPHERS

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YEARBOOK

OF THE

ASSOCIATION OF PACIFIC COAST GEOGRAPHERS

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The San Diego Meeting

The fourth annual meeting of the Association of Pacific Coast Geographers was held at San Diego, California, June 23rd to 25th, 1938. Mrs. Alvena Storm of the San Diego State College was chairman of the committee on local arrangements, assisted by Dr. Lauren C. Post of the same institution. Two field excursions were features of the meeting. One, conducted by Mrs. Storm, described the historical evolution of San Diego. The other excursion, on Saturday, the 25th, was in charge of Dr. Lauren Post and Dr. Peveril Meigs 3rd, and visited the coast and "fog" desert of Baja California. Special luncheons were held on Thursday and Friday, with the annual dinner Friday evening at which Vice-President Leighly spoke on "Methodologic Controversies in the Nineteenth Century German Geography." Dr. Leighly mentioned the mystical attitude of Karl Ritter, occupant of the first academic chair ever established in Geography, and the gradual breaking away of geographers from the Rittarian philosophy, leading to development of modern regional geography.

Fourteen papers were given during the two days of the meeting. Four of these papers presented at the meeting are included in full in this volume of the yearbook, with abstracts of the others. This copy of the yearbook contains more illustrations than have previously been used. It is expected that beginning next year the yearbook will be considerably enlarged as greater income from memberships becomes available.

The number of active members in the Association totals ninety-six individuals. In addition, many libraries and other institutions subscribe regularly to the yearbook. During the last year, copies of the yearbook have been purchased by institutions in England, France, Belgium, U. S. S. R., and the Chinese National Library at Hong Kong.

The 1939 Meeting and Officers

The next meeting of the Association of Pacific Coast Geographers will be held in connection with that of the Pacific Division of the A. A. A. S. at Stanford University during the week of June 26th to July 1st. It is hoped that a record number of members will be in attendance at the fifth annual program meeting.

Officers elected who will serve at the 1939 meeting are:

John B. Leighly, University of California, President.

Frances M. Earle, University of Washington, Vice-President.

Peveril Meigs 3rd, State College, Chico, California, Secretary-Treasurer.

Otis W. Freeman, Eastern Washington College of Education, Cheney, Washington, Editor of Yearbook.

YEARBOOK OF THE ASSOCIATION OF PACIFIC COAST GEOGRAPHERS

VOL. IV. 1938

Aboriginal Trade Routes for Sea Shells in the Southwest

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Sea shells, when found in archaeologic ruins and middens of the Southwest, may provide data concerning prehistoric customs, techniques, and trade. This paper attempts to outline the methods and results of a study, into prehistoric trade routes in the Southwest, based upon the distribution of marine shells.

The study was initiated by examining all possible literature on, and museum collections from, the area (arbitrarily taken as all of Arizona and New Mexico, most of Utah, and portions of adjacent entities) for mentions or exhibits of molluscan shells.[1] The following difficulties were encountered almost immediately:

1. A great army of the reports on excavations failed to mention shells at all, or used such vague terms as "shells", "molluscs", "clams", "snails", and the like. At some sites, especially toward the northeastern interior, a lack or paucity of shell material might be expected, but such a condition on middle tributaries of the Colorado River is rather difficult to explain. Probably, in most of such reports, neither the excavators nor the reporters were either interested or versed in malacology, and consequently failed to grasp the importance of preserving and recording all shell material—both worked and unworked. Only in recent years has more than a paragraph or two been devoted to discussing the molluscan finds of an excavation.[2]

2. In the reports that made some pretence to listing the individual species, there was a wide variation in completeness, method, and accuracy of nomenclature. Some monographs gave only common names (such as white olivella, large Pacific clam, conch, whelk, cockle, scallop, and the like) which seldom could be narrowed down to the proper genus and practically never could be identified with a species. Quite often, seemingly, the excavators made their own field and museum identifications. It is possible that this procedure has conditioned the preponderance of *Olivella, Glycymeris, Oliva, Conus, Haliotis, Cardium,* and *Pecten* identifications, since these seven most commonly mentioned genera probably are the seven easiest for the layman to recognize. Even when experts have been called in,[3] there has been much discrepancy in the manner of citation and in the checking of obsolete or less valid synonyms. An example of this is one of the olives, which has been cited as: *Oliva hiatula, Agaronia hiatula* Gme lin, *Agaronia testacea* Lamarck, etc. One should not object, however, to many specific uncertainties in identification since most archaeologic shell material cannot be identified because of being (a) too altered by work (as is true of nearly all disc beads), (b) too fragmentary, or (c) too decayed.

3. Much of the archaeologic Southwest has not been worked, either in time or in space. This is especially true of the so-called Developmental or Pueblo I and II periods (roughly 600 to 950 A. D.) of "culture time", and of the Eastern Periphery, Middle Rio Grande, Chihuahua, and Sonora areas. Consequently, any

study in distributions must contain lamentable hiatuses.

After determining what genera and species had been found (with subsidiary notes on use and culture period), the next step was to establish the actual, most probable, or possible provenience of each genus and of ecah species. This was the most difficult portion of the study because of disagreements among conchologic authorities as to terminology, synonyms, and areal distribution.[4]

In general the areal disagreement was along lines unimportant for this study, e. g., whether a species was only in the Gulf of California or extended around to Magdalena Bay, or whether a species was found southward only to San Diego or extended to Cedros Island. In a few cases bad errors may have been introduced, as in Boekelman's identification (Gladwin, et al.: *Excavations at Snaketown*) of a shell as *Alectrion vibex* Say (of Atlantic origin) when the shell probably was *Nassarius* (*Alectrion, Nassa*) *tiarula* Kiener (of Pacific origin). These two species are so similar that it might be said that they differ geographically rather than morphologically. Also, it is possible that *Pecten gibbus* var. *irradians* (identified by Wing for Nesbitt: *Starkweather Ruin*), of Atlantic origin, may be one of the Pacific varieties since *Pecten gibbus* is well represented on the Pacific Coast, as in *Pecten gibbus* var. *circularis*, etc. The following list presents alphabetically, within classes, the areas of origin of all identified genera and species known to the writer.

PROVENIENCE OF SHELLS

Gulf of California

Gastropoda:

- *Acmaea fascicularis* Menke
- *Agaronia testacea* Lamarck (*A. hiatula* Gmel., *Oliva hiatula* Gmel., *O. testacea* Lam.)
- *Anachis* (*Columbella*) *coronata* Sowerby:
- *Cerithidea albonodosa* Carpenter
- *C. mazatlanica* Carpenter
- *Cerithium stercus-muscarum* Valenciennes
- *Conus fergusoni* Sowerby
- *C. princeps* Linn.
- *C. purpurascens* Broderip
- *C. regularis* Sowerby
- *Galeodea patula* Broderip (*Galeodes patulas, Pyrula patula*)
- *Melongena patula* Brod. & Sow. (*Pyrula patula, Galeodea patula*)
- *Murex* (*Phyllonolus*) *radix* Gmel. var. *nigritus* Phil.
- *Nassarius* (*Alectrion, Nassa*) *complanatus* Powys
- *N. leucops* Pils. & Lowe
- *N. moestus* Hinds (*N. brunneostoma* Stearns)
- *Nerita bernhardi* Recluz.
- *Neretina picta* Sowerby
- *Oliva angulata* Lamarck (*O. incrassata* Sol.)
- *O. verulata-hemphilli* Johnson (*O. spicata* Bolt. var. *hemphilli* John.)
- *Olivella dama* Mawe (*O. dama* Gray, *O. dama* Wood)
- *O. tergina* Duclos
- *O.* (*Oliva, Lamprodoma*) *volutella* Lamarck
- *Pyrene* (*Columbella*) *major* Sowerby
- *Strombus galeatus* Swainson
- *S. gracilior* Sowerby
- *Turbo* (*Astraea, Callopoma*) *fluctuosum* Wood
- *Turritella leucostoma* Valenciennes (*T. tigrina* Kien.)

Pelycypoda:

- *Arca pacifica* Sowerby
- *A. tuberculosa* Sowerby
- *Chama echinata* Broderip
- *Glycymeris* (*Pectunculus*) *bicolor* Reeve
- *G. giganteus* Reeve
- *G. maculatus* Broderip

Macrocallista (*Pitar, Cytherea*) *squalida* Sowerby
Pecten vogdesi Arnold (*P. excavatus* Anton)
P. (*Lyropecten*) *subnodosus* Sowerby
Pteria (*Avicula*) *Peruviana* Reeve

Pacific Coast

Gastropoda:
Cerithidea Californica Haldemann (*C. sacrata* Gould)
Conus Californicus Hinds
Erato vitellina Hinds
Haliotis cracherodii Leach
H. fulgens Philippi
H. rufescens Swainson
Northia (*Searlesia*) *dira* Reeve
Olivella (*Oliva*) *biplicata* Sowerby

Pelycypoda:
Pecten circularis var. *aequisulcatus* Carpenter

Pacific Coast and Gulf of California

Gastropoda:
Polinices (*Neverita*) *recluzianus* Deshayes
Trivia solandri Gray
Vermetus (*Aletes*) *centiquadrus* Valenciennes
V. (*Aletes*) *squamigerus* Carpenter

Pelycypoda:
Cardium (*Laevicardium*) *elatum* Sowerby
Chama buddiana C. B. Adams
Dosinia ponderosa Gray
Pecten (*Aequipecten*) *gibbus* var. *circularis* Sowerby
Spondylus princeps Broderip (*S. limbatus* Sow.)
Tagelus Californianus Conrad

Atlantic Waters

Gastropoda:
Fasciolaria distans Lamarck
Nassarius (*Alectrion, Nassa*) *vibex* Say
Neritina reclivata Say
Oliva sayana Rav.
Strombus gigas Linn.
S. pugilis Linn.

Pelycypoda:
Cardium robustum Solander
Noetia (*Arca*) *ponderosa* Say
Pecten gibbus var. *irradians*

Genera Possible From All Waters (Species not determined)

Cadulus sp.
Cypraea sp.
Tritonalia sp.
Chione sp.
Tivela sp.

Altogether, 132 archaeologic sites were reported to contain from one to 33 species each of marine shells, which provided a total of 41 genera and 66 different identified species. Thirty-eight of these species could have been obtained only from the Gulf of California; another ten species could have been secured from either the Gulf of California or the Pacific Coast of California, or both; and an additional nine species could have come only from approximately the present Southern California Coast. Thus, a total of 57 species were of general Pacific origin, and nine came from Atlantic waters. In this connection it is interesting to note that subtropical and tropical waters, rich in molluscan fauna, contributed all of the identified species. The subtropical Pacific (Southern Californian — Point Conception to Cedros Island) and Atlantic (Northern Gulf of Mexico) faunal zones contributed nine species each, and the tropical Gulf of California zone (essentially Cedros Island or, better, Magdalena Bay to the Tres Marias Islands) produced at least 38 species. This latter production is not

surprising in view of the observation that the richest molluscan collecting grounds on the west coast of North America are around La Paz, whence have been obtained 90 bivalve and 110 univalve species.

It should be observed that the three classes of the phylum Mollusca represented archaeologically in the Southwest are present roughly proportional to the absolute number of species in each class. Class Gastropoda (49,000[2] species) is represented by 46 species; Class Pelycypoda (7,000[2] species) is represented by 20 species; and Class Scaphopoda (200[2] species) is represented by one genus, species undetermined. The reason for such a distribution of species by classes does not, however, lie entirely in the relative abundance of species in the various classes. It should be kept in mind that the peoples of the interior Southwest did not obtain the various marine molluscs for food at all (unless it were a small amount of dried shellfish), but rather for ornamentation and ceremonial usage.[3]

Fully ninety per cent of the marine shells found in archaeologic sites have been worked in some fashion, which might indicate selection of shell for elaboration rather than as the natural containers of food. Furthermore, an inspection of the shells found in kitchen middens of the San Francisco Bay, Southern California Coast, and Seri Indian areas shows that *Mytilus, Macoma, Ostrea, Cardium, Tapes, Purpura, Cerithidea, Haliotis, Acmaea, Tivela, Solen, Astraea, Pecten* and *Polinices* along the California Coast were most prized for food; *Pitar, Arca, Tivela, Chama, Paphia, Glycymeris, Dosinia, Macrocallista, Pteria, Mactra, Pecten, Cardium, Murex, Polinices, Mytilus,* and *Turbo* were most utilized along the Sonoran Coast; and, of these 25 genera most commonly used for food by aborigines along the coasts, only *Glycymeris, Haliotis, Cardium,* and *Pecten* (in that order) are at all common in the Southwestern ruins. Specifically, *Glycymeris maculatus, Haliotis cracherodii,* and *Haliotis fulgens* were the only molluscs, much used for food on the coast, whose shells were traded inland in large numbers.

There is no archaeologic or ethnologic evidence for use of marine molluscs for dye, textile, or currency in the Southwest. Although worked and certain unworked shells were (and are) highly prized, all the indications are that the values were primarily aesthetic and ceremonial, and that shells never have functioned as measures or units of value. This Southwestern disregard for shells as currency is in decided contrast with the attitude of the tribes of the Middle Atlantic (peak or wampum of clams), Northwest American (strings of dentalia), and Californian (money of worked abalone, *Olivella,* etc.) coasts.[4]

In the Southwest sea shells were used predominantly for ornament, in the form of beads (mainly *Olivella, Oliva, Conus, Haliotis, Turritella, Cerithidea, Nassarius, Trivia, Vermetus,* and various bivalves which were ground into disc beads and are very difficult to identify), pendants (chiefly of *Haliotis, Glycymeris, Cardium, Pecten,* and *Turritella*), bracelets (principally of *Glycymeris*), rings, placques, etc. Presumably ceremonial in utility were such forms as trumpets (*Strombus, Melongena, Murex*), receptacles for corn pollen, ground turquoise and the like (usually whole *Haliotis*), and eccentric figures and forms carved usually from large heavy walled marine shells. In general marine shells were preferred over land and fresh water shells because the latter were less durable and not so massive, and consequently were not so well suited for carving. Only infrequently were shells used for tools such as needles, awls, and hooks.

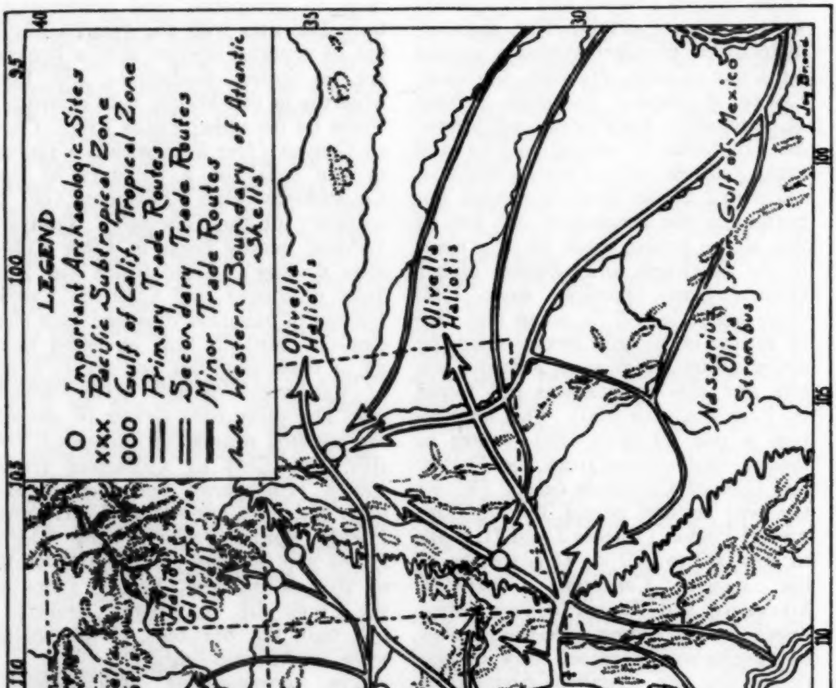
In absolute numbers, and by sites at which they have been found, shells

of the genera *Olivella* and *Glycymeris* were most important. The approximate order of other common genera is: *Oliva, Conus, Haliotis, Cardium, Pecten, Nassarius, Turritella, Pyrene* (*Columbella*), *Cerithidea*, and *Strombus*. In terms of spread in time and area, *Olivella, Glycymeris, Haliotis, Oliva* and *Conus* have been most important in the Southwest. All five of the above genera have been present in the Southwest since Basket Maker cultural time (possibly since 1500 years ago). It will be noted that *Oliva sayana* is the only species from the above group which is of Atlantic origin, and this species was not found in Basket Maker time. The implication is that all early trade routes in marine shells were from the Pacific and Gulf of California coasts. During the next cultural period, the Developmental Pueblo (Pueblo I and II, more or less 600 to 950 A. D.), species of the genera *Cardium, Cerithidea, Strombus*, and *Turritella* were introduced. In succeeding time the number of genera was increased very considerably for the so-called Anasazi or Basket Maker-Pueblo Plateau area, which is the northeastern portion of the Southwest. In the Hohokam-Trincheras area (the southwestern portion of the Southwest) introductions were probably much earlier in the case of every genus originating from western waters.

Worked shell is most commonly found in inhumations and with cremations. Unworked shell, discards, and fragments occur most frequently in refuse. The number of sites with reported marine shell is largest in Arizona and northern Soonra, followed by northern Chihuahua and New Mexico, with western Texas, Utah, Nevada and Colorado in descending order. This distribution probably represents three factors: 1. distance from the sea, 2. amount of archaeologic work carried out and reported upon, and, 3. nature of barriers to occupation and communication. The sites with the greatest number of reported species and/or genera are, in order, Snaketown and Los Muertos in the Middle Gila drainage, Pecos on the upper Pecos River, Chaco Canyon (five sites within a radius of one mile) on a tributary of the Colorado-SanJuan, Tuzigoot (on a tributary of the Gila-Salt), Tusayan (several nearby ruins in Little Colorado drainge), Aztec Ruins (in San Juan drainage) and Cameron Creek Village in Mimbres drainage (see circles on map). It will be noted that all of these sites but two are in Gulf of California-Colorado River drainage. The three sites richest in species are situated near a confluence of Pacific and Gulf of California trade routes (Snaketown and Los Muertos), and at an outpost of Rio Grande Pueblo culture against the High Plains and on Pecos-Rio Grande-Gulf of Mexico drainage (Pecos). Even at the Pecos site, in Atlantic drainage, less than ten per cent of the shells were of Atlantic origin.

The accompanying map incorporates the main conclusions as to probable routes of shell movement. With reference to this map the following comments should be made:

1. The absolute and relative amount of shell trade from the Gulf of Mexico to the Southwest was small. Only ruins along the Pecos River, in northern Chihuahua, and in the Mimbres drainage possess any appreciable number of Gulf of Mexico shells. All such areas are east of the Continental Divide. Two sites in Pacific drainage have had one species each reported from the Gulf of Mexico. These are Snaketown (*Nassarius vibex*) and the Starkweather Ruin (*Pecten gibbus* var. *irradians*). Previously there has been pointed out the strong possibility of error in both cases. Although Pacific and Atlantic waters have many genera in common, most malacologists will not allow



Postulated Trade Routes

common possession of any species. It is possible that *Alectrion vibex* and *Pecten gibbus* are exceptions and, therefore, invalid as indicators of provenience.

2. *Haliotis* sp. and possibly *Olivella biplicata* into southwestern Colorado, and *Haliotis* sp. into the Panhandle of Texas, constituted the most north and eastward spread of Pacific Coast shells. Also, other than these two genera no shells of purely Pacific Coast origin have been reported east of the Rio Grande. Nor have any Pacific Coast shells been reported from Sonora or the Big Bend region of the Rio Grande.

3. No Gulf of California shells were worked along the Pacific Coast of upper California, nor eastward into Nevada. The spread of Gulf of California shells into Utah and Colorado was slight and comprised chiefly *Glycymeris* sp., *Olivella dama*, and *Olivella volutella*.

4. Seemingly there were two main western routes (one from the California Coast, the other from the Sonora Coast) that converged upon the Middle Gila area. The northern route carried mainly *Haliotis* sp. and *Olivella biplicata*; the southern route provided the bulk of the shells found in the Southwest. From the Middle Gila-Lower Salt area routes diverged northward and eastward into the drainage basins of the Little Colorado, San Juan, and the western affluents of the Rio Grande. The natural setting was such as to make the shores between the Colorado and Yaqui deltas the chief gathering grounds, nearby sites (principally in the Altar and Sonora drainages) places of primary elaboration of some of the larger and heavier shells (e. g., *Glycymeris*), and settlements in the Gila Valley (near the crossroads afforded by the Santa Cruz-Salt and Lower and Upper Gila) the final elaborators, arbiters of style in shellwork, and middlemen for both worked and unworked goods going northward and eastward. Subsidiary routes up the Sonora and Yaqui rivers probably delivered the bulk of shells received in the interior drainage basins of northwestern Chihuahua, and continued to join with the Gila routes in feeding the Mimbres and Rio Grande areas. Trade routes up the Brazos, Colorado, and Rio Grande-Pecos brought in the bulk of Gulf of Mexico shells, which were principally *Nassarius vibex, Oliva sayana*, and *Strombus* sp. The vicinities of Pecos Pueblo, Ojinaga, and El Paso were in strong crossroads position, which strength of location was expressed in comparative richness of marine shell material.

5. Future work will undoubtedly add to the species and genera, and will fill in details of distribution, but there should be little change in proportion of Atlantic to Pacific shells, major trade routes, or relative importance of the already identified species.

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[1] This portion of the study was carried on through library work, correspondence, and travel—by the writer sporadically from 1930 to the present, and by one of his graduate students, Mr. John M. Goggin, who rendered invaluable aid during 1937 and 1938.

[2] Some of the better reports, in chronological order, are:

Fewkes, J. Walter, "Pacific Coast Shells from Prehistoric Tusayan Pueblos", **American Anthropologist**, o. s., vol. IX, 1896.

Morris, E. H., "The Aztec Ruin", American Museum of Natural History **Anthropological Papers**, 26:1, 1919.

Bradfield, W., **Cameron Creek Village**, Santa Fe, 1931.

Kidder, A. V., "The Artifacts of Pecos", **Papers** of the Phillips Academy Southwestern Expedition, No. 6, 1932.

Caywood, L. R. and E. H. Spicer, **Tuzigoot**, Berkeley, 1935.

Brand, Hawley, Hibben, et al., "Tseh So, A Small House Ruin, Chaco Canyon, New Mexico", University of New Mexico **Bulletin** no. 308, Anthropological Series Vol. 2, no. 2, 1937.

Gladwin, Haury, Sayles, Gladwin, "Excavations at Snaketown: Material Culture", **Medallion Papers** no. XXV, 1937.

[3] Dr. Stillman S. Berry, U. S. Bur. of Fisheries, Redlands, California.

Dr. H. J. Boekelman, Curator of Ethnoconchology, Louisiana State Museum, New Orleans.

Mr. William J. Clench, Harvard Museum of Comparative Zoology, Cambridge, Mass.

Dr. Howard Hill, Los Angeles Museum, California.

Dr. Roy W. Miner, Curator of Living Invertebrates, American Museum of Natural History, N. Y.

Mrs. Kate Stevens, former Curator of Molluscs, San Diego Museum of Natural History, California.

have made most of the published identifications during the past twenty years.

[4] The author here desires to acknowledge his great obligation to Dr. Paul Bartsch (United States National Museum), Dr. Leo G. Hertlein (California Academy of Sciences), Miss Viola Bristol (Museum of Natural History, San Diego), Dr. Willard Van Name (American Museum of Natural History), Dr. Bruce Clark (University of California), Dr. Howard Hill (Los Angeles Museum), and Mrs. Kate Stevens (San Diego, California), all of whom aided in unraveling the tangled skein of synonymy. For lack of space no discussion is here given concerning various changes made in the genus and species names of some shells identified in archaeologic literature.

Useful manuals were:

William H. Dall: "Summary of the Marine Shellbearing Mollusks of the Northwest Coast of America, from San Diego, California, to the Polar Sea", U. S. Nat. Mus. **Bulletin** 112, 1921.

U. S. Grant IV and H. R. Gale: "Catalogue of the Marine Pliocene and Pleistocene Mollusca of California and Adjacent Regions", San Diego Society of Natural History **Memoirs**, Vol. 1, 1931.

Josiah Keep (Rev. by J. L. Baily, Jr.): **West Coast Shells**, Stanford Univ., 1935.

Mrs. Ida S. Oldroyd: "The Marine Shells of the West Coast of North America", **Stanford Univ. Pub., Univ. Series, Geol. Sciences**, vol. 1, no. 1; vol. 2, pts. 1, 2, 3, 1924-1927.

Mrs. Julia E. Rogers: **The Shell Book**, rev. ed., New York, 1931.

Walter F. Webb: **Handbook for Shell Collectors**, Rochester, 1936.

[5] Sea shells have been used by various peoples for such purposes as food (cockle, scallop, oyster, mussel, clam, whelk, conch, etc.), dye *Purpura Murex, Fasciolaria*), pearly ornament (*Meleagrina, Turbo*, etc.), dye (*Purpura Murex, Fasciolaria*), (cowry, spiny oyster, *Venus, Mytilus, Dentalium, Haliotis, Buccinum, Pyrula, Olivella*, etc.), trumpets (*Strombus, Melongena, Murex*, etc.), dishes (*Halliotis, Tivela*, etc.), tools (pieces of shell worked into needles awls, etc.), etc.

[6] See R. E. C. Stearns "Ethno-Conchology: A Study of Primitive Money", U. S. Nat. Mus. **Annual Report** for 1887, pp. 297-334; and other articles by Stearns in **The American Naturalist** for 1869 and 1877, and **Proceedings** of the California Academy of Sciences, vol. 5, 1873.

The Simi Valley, Ventura County, California

ROBERT M. GLENDINNING

University of California at Los Angeles

A chorographic interpretation of the Simi Valley, stressing the interrelationships among the basic physical factors and the factors of settlement and land utilization. An abstract covering the essential portions appears in the Annals of the Association of American Geographers, Vo. XXVIII, No. 1, March 1938, pp. 47-48. The entire paper will be published in the "Geographical Journal" about January 1, 1939.

The Sandy Areas of the North American Desert

FORREST SHREVE
Desert Laboratory of the Carnegie Institution of Washington

It is widely believed that all deserts have a sandy surface which is bare of vegetation and constantly agitated by the wind. Such a picture is true of large areas in the Sahara, the Libyan Desert, Arabia, Turkestan, and the Desert of Gobi. In the North American Desert, however, the prevailing type of surface is stony or hard. There are many very small areas of stable or wind blown sandy soil. Only in a few areas (see Fig. 1) is there sufficient extent of sandy surface to affect physiographic development, the aspect of the landscape, or the nature of the plant and animal life. These areas lie near the International Boundary and are scattered from southern California to western Texas. They differ in origin and history, at the same time that their surface features and physiographic development are very similar. There are very few species of plants confined to the sandy deserts but they have a number of distinct races of reptiles and small mammals. The vegetation is distinct from that of the stony deserts on account of differences in density, the relative abundance of widespread species, and the irregular emplacement of most of the plants.

The largest series of sandy areas is found in the region surrounding the head of the Gulf of California. These include the Whitewater Sands, near Indio, California, the Algodones, east of the Salton Sea, and a long irregular stretch of sandy plain west of Imperial Valley and the delta of the Colorado River. A small dune area is found on the east coast of Baja California immediately south of Bahia San Felipe. In extreme northwestern Sonora a very large area of sandy plains and dunes borders the Gulf coast, extends north into Arizona, surrounds the Pinacate lava fields and skirts the coast as far south as Cirio Point. A detached sandy area occupies most of the valley between the Mohawk and Gila Mountains, in Arizona. A smaller area in

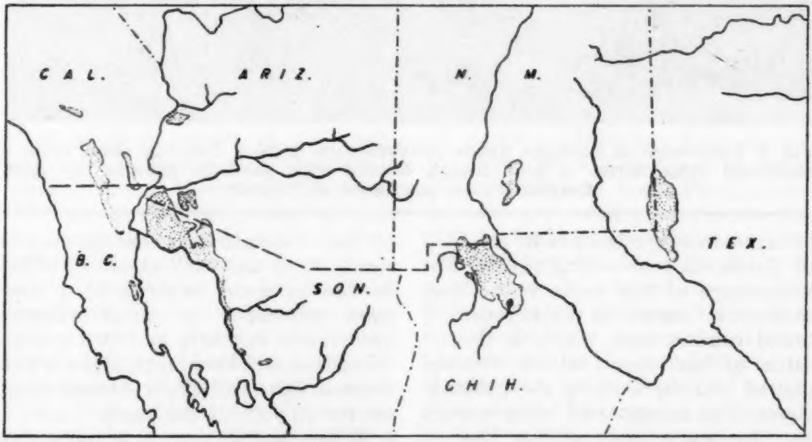

Fig. 1. Map of southwestern United States and northwestern Mexico showing the large sandy areas in the desert region.

Arizona lies between Bouse and Parker.

It seems probable that the three areas of very light colored sand in California are the products of wind erosion in the trough of the ancient dry bed of the Salton Sink and of wind selection from the copious outwash of streams draining the desert face of the San Jacinto and Cuyamaca Mountains. The light yellow sand of the Pinacate area and the Mohawk Valley has probably been transported any of the silt that has been moved by the Colorado in recent decades. In the Pinacate region it is obvious that the sands owe their present extent to the prevailing southwesterly wind. Sand is piled high against the western base of the Pinacate volcano and several smaller mountains near it (see Fig. 2). Long sandy ridges extend for 10 to 15 miles opposite each opening in the series of hills and small mountains which roughly parallels the coast. Over much

Fig. 2. Landscape in Pinacate Sands, northwestern Sonora. Looking south from a stabilized ridge across a bare trough toward hills partially covered by sand. Locality 28 mi. southwest of Sonoyta.

by wind from the beaches of the Gulf of California over a long period. The wide range of tide levels in the head of the Gulf results in the exposure of broad beaches onto which is thrown some of the vast load of material poured into the Gulf by the Colorado River. The existence of other sources for the beach sand of the Gulf is indicated by the fact that a small fraction of the sand is coarser than of the Pinacate area the surface is nearly level and well stabilized. This is due in some localities to a very open pavement of small volcanic stones, and in others to a rich growth of lichens and blue-green algae which form a light and easily broken crust on the surface of the sand.

Wherever the sand is in active movement at the present time the vegetation is very sparse or absent.

Some of the dunes and sandy ridges have been stabilized, usually by the presence of sand galleta grass (*Hilaria rigida*). On the sandy plains the vegetation is heaviest where galleta grass has become well established, and is extremely open where the bur franseria (*Franseria dumosa*) and the creosote bush (*Larrea tridentata*) are the only common perennials. Here, as in all sandy areas, there is a strong contrast between the thin cover of perennial plants and the heavy carpet of annuals which springs up after a single heavy rain. The only plant confined to the sand areas around the head of the Gulf, so far as known, is the "sand food" (*Ammobroma sonorae*), which is parasitic on the roots of *Franseria* and *Dalea*.

There is a small sandy area of about 150 sq. mi. southeast of Parker, Arizona. Its surface is relatively level except at the eastern end of the area, where there are dunes with an east and west trend. The vegetation is extremely thin, consisting of small individuals of *Franseria* and *Hilaria*, with very widely spaced small bushes of *Larrea* and *Ephedra*. It is difficult to hazard a guess as to the origin of the sand in this area, which is a deeper shade of yellow than the sand in the Pinacate region.

In the Otero Basin, in southern New Mexico, is one of the best known areas of sandy desert in the southwest, now comprised in the White Sands National Monument. This area fills the center of the valley between the Sacramento and San Andreas Mountains and surrounds a playa which is seasonally flooded by Tularosa Creek. This stream drains a large forested area in the Sacramento and Sierra Blanca Mountains. At the southern end of the basin the sand is a very clean white and is almost pure gypsum. At the northern end it is a very light gray and is chiefly quartz. The dunes and sandy plains surrounding the playa have been built by the wind, which removes the finest crystals from the dry surface of the lake bed after the rapid evaporation of its storm water. It is of some interest that this area of sand desert is being built up today with material transported by Tularosa Creek from ancient Permian desert deposits exposed on the Sacramento Mountains.

The plant covering of the White Sands is a very sparse and irregular stand of shrubs on the active dunes and moving surfaces, and is a low and open stand of grasses and small shrubs on the relatively stable areas. The plants are all species which are abundant in the surrounding region except a shrubby mint, *Poliomintha incana*, which occurs on sand elsewhere. This shrub flourishes on the lee side of some of the most active dunes and is more effective than any of the grasses in helping to stabilize the wind blown surfaces.

In northern Chihuahua is a large area known as the Samalayuca Sands, in which there are some very large dunes as well as extensive areas in which the topography is determined by the action of the wind. The sand here is light gray in color and almost white in some of the dunes. The extent of the area is shown in a recent paper by Brand (1937) on the Natural Landscape of Northwestern Chihuahua. A large part of the drainage of northern Chihuahua finds its way into three lakes, Lago Guzman, Lago Santa Maria and Lago Patos, situated west and south of the sands. The streams feeding these lakes have eaten far back into the highland plains derived from the degradation of the Sierra Madre Occidental and have contributed vast quantities of sand and alluvium to the upbuilding of the Samalayuca area. The beds of the three shallow lakes are partly or wholly dry in the rainless seasons and wind action has transported material from them for distances of 30 to 50 miles. The potential outlet of the three

drainages into the Rio Grande has thus been cut off, a condition probably now of long duration.

The vegetation of the Samalayuca area is very similar to that of the White Sands and very unlike that of the hard and stony bajadas immediately to the southeast. A few species of plants are abundant in the sands which are uncommon elsewhere, but none have yet been detected which are endemic to them.

At the southeastern corner of New Mexico is a large sandy area, lying chiefly in Texas. This is the only one of the areas herein mentioned which the writer has not seen. It is described in a bulletin by Carter (1931) on the Soils of Texas as having a rolling surface with very little dune development. A thin cover of grasses has invited some unsuccessful attempts at cultivation. According to Parks (1937) the dominant perennial plant in 12 counties in the sandy area is the shinnery oak (*Quercus Havardi*), which grows in pure dense stands with a height of 8 to 24 inches. The oak spreads by underground branches and is reported to be an excellent sand binder. It is a plant not known outside this section of Texas. The existence here of a strongly dominant plant which is endemic to the area suggests the possibility that the Texas sandy area may be much older than the other areas that have been described, in which the plants (with the single exception noted) are merely natural selections from the vegetation of surrounding regions.

The agricultural possibilities of sandy soils are low in any place and particularly so in desert regions. There has therefore been relatively little investigation of the physics of such soils, particularly with reference to permeability, penetration and availability of water. Penetration of rain into the surface layer of a sandy soil is rapid. Evaporation from the surface is also rapid and results in a dry mulch which retards further evaporation. No investigations have been carried on in any of the areas described in this paper to determine the precise rate and extent of penetration, nor the history of the upward movement of water after the restoration of a dry surface layer. Hall (1938) has recently discussed the rainfall and ground water of the Sand Hills of Nebraska, which lie between the Platte and Niobrara Rivers in the western part of the state. There a definite water table exists at a depth which varies seasonally and annually and a vast body of ground water is maintained by the ready penetration of the light rainfall. Dubiansky (1928) has described a similar condition in the sandy Karakum Desert of Turkmenistan.

In all of the North American sand desert areas a few large and thriving perennial plants are found here and there in the dune areas. These plants appear to be the exceptional individuals which have been able to develop a deep seated root system in levels of the sand which provide available water throughout the year. The scarcity of such plants is probably not due to a general lack of adequate water supply at lower levels so much as it is to the difficulties which the seedlings and young plants encounter in becoming established in a soil in which the surface layer is physiologically dry for at least 340 to 350 days in the year.

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Lima Bean Farming and Soil Erosion in the Encinitas Area

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In San Diego County there are three areas of production of lima beans. One area lies in the north of the county and is strung shoestring-like along the younger terraces of the coast. A second area takes in the large block of sandy clay-loams on the Otay Mesa in the southwestern part of the county. The third area is the Encinitas District and is the one to be discussed in this paper.

Encinitas is a small coastal town 20 miles north of San Diego. It is the center for the bean farming which has developed in this vicinity. This area comprises a rather neat geologic, physiographic, and pedologic unit, with clear cut boundaries. The younger terraces along the shore line mark the western boundary. The eastern boundary is defined by two factors which tend to coincide. First, a line of crystalline hills which parallel the coast at a distance of 5 to 6 miles. Second, by a climatic boundary also parallel to the coast 5 to 6 miles back which marks the effective limit of penetration of oceanic influence for lima bean production. Approximately 9 miles to the north and 9 miles to the south occur geologic changes which alter the physiographic and pedologic conditions, and determine the northern and southern boundaries

Figure 1.

Geologically this area is a wave cut terrace of Pleistocene Age. This terrace, locally called the Linda Vista Mesa, averages 400 feet in height and is in the Encinitas area cut into massive Eocene sands of the Torrey and Del Mar formations. These massive sands extend from Torrey Pines to Carlsbad. North of Batiquitos Slough they are, however, more heavily capped with gravel. In this northern segment there has been less erosion and this is reflected today in greater expanses of original terrace surface and less bean production. To the south, the area is bounded by the Poway gravels, to the north by harder, limier Eocene deposits, and to the east by a range of hills of crystalline rocks.

The geology is reflected in the physiography. The area underlain by Eocene sands is one of greater dissection and its topography more nearly approaches maturity than that of the surrounding areas. Erosion has progressed more rapidly since the Pleistocene, and gentler slopes, and broader valleys have been developed. These slopes and valleys have been utilized for crops. The greatest differentiation of topography occurs in the region of Torrey Pines on the southern boundary of the area. Southward the mesa is dissected by

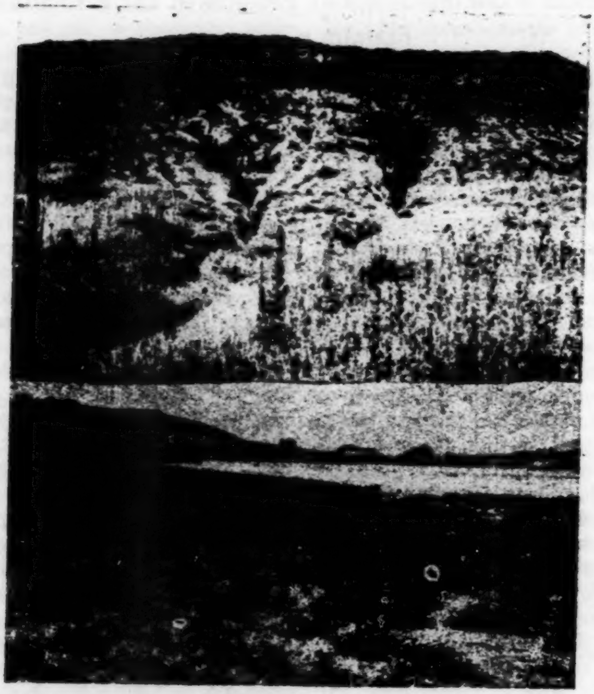

Figure 2. (Upper) Gullying at the shoulder of an abandoned bean field.
Figure 3. (Lower) Heavy sand deposition at the mouth of an arroyo forming a barren delta in the center of a formerly fertile field.

steep sided canyons and large areas of original surface remain. Northward the amount of erosion is much greater and the percentage of mesa surface is correspondingly less. Of interest in this eroded area is the development of asymetrical slopes. The north facing slopes are quite uniformly much steeper than the south facing slopes. It is on the gentler slopes that the best soils have developed, and it is here that many of the beans are grown.

Soil types reflect both the geology and the physiography of the region. The Eocene sands have given rise to a series of sandy loams. On the remnant mesa tops these soils approach mature development of profile. Due to their partially consolidated substrata they make only fair agircultural soils. On the gentler slopes of the valleys soils of moderate profile development occur. These soils have but slight accumulation of clay or lime in their subsoil. The best of these soils is the Botella loamy sand, and it is the favorite lima bean soil. It has sufficient water-holding capacity and depth so as to permit the storage of sufficient moisture to mature the crop. It has a sufficient amount of essential plant food and is free from surplus water and injurious chemicals. On

the canyon floors are sandy alluvial soils of but incipient profile development. These soils also are light, warm, easily worked, and of sufficient water holding ability to make very good bean soils.

Of the climatic needs of the lima bean, Zierer has written as follows: "Limas require hot summer weather for their best growth, but if the sunshine is too intense or the relative humidity too low, the yield is greatly reduced. It is said that 'limas will make a crop out of fog.' In lima bean districts summer fogs are characteristic and it has been demonstrated that the plant will not produce satisfactorily in those districts which summer fogs do not penetrate." These conditions are met in San Diego County along the coastal border where summer fogs are common. [1]

In this vicinity the summer fogs only penetrate inland about six miles, or approximately to the line of crystalline hills. Hense the geology, physi-

Figure 4. (Upper) Burial of fence posts resulting from the heavy rains of the winter of 1937-1938.
Figure 5. (Lower) General view of a bean field area with sand burial through sheet wash in the foreground, and cliffs of eocene sands in the background.

ography, and climate all coincide to establish this eastern boundary. Summer sun is intense in Southern California and temperatures at inland statios rapidly become excessive. The beans, therefore, are rigidly restricted to the narrow coastal belt which is strongly under oceanic influence. This area is near the arid boundary of lima bean farming. The rainfall averages between 9 and 10 inches, but is quite variable from year to year. More important to the farmers than amount is the distribution of rainfall. Late spring rains are most helpful and a satisfactory crop can be raised in quite dry years if the rain comes at this time. In such years the summer fogs and the sea breezes are counted on to supply moisture, keep the humidity from going too low, and the temperature from going too high. In one way the climate in this more arid zone favors the bean farmer. There is a longer growing season and there is less chance of loss due to early rains coming while the crop is drying in the fields.

This area has been in use since Spanish times. Encinitas derives its name from the Spanish land grant of Encinitas which lies within the district. At that time the land was used for grazing purposes. Under American ownership small scale farmers took the land over and cropped it to small grains and corn. Erosion under the Spanish regime is thought to have been nearly absent. Old timers agree that erosion was not serious in the early 1900's.

In 1868 in the vicinity of Carpenteria, California, occurred an event which was to change this picture. Legend has it that a certain Mr. Mc-Callister of that place had occasion to entertain a Yankee ship captain just up from Peru. The following day the captain had McCallister aboard the ship for dinner. During the meal he obtained some beans which he took ashore and turned over to a farmer named Henry Lewis. There ensued a long period of experimentation to establish methods of cultivation and marketing. Eventually a market was established and lima bean farming became quite lucrative and began to spread rapidly.

By the early 1900's lima beans were being grown in the vicinity of Oceanside, 20 miles north of Encinitas, and kowledge of the crop was spread on south. In 1907 a Mr. Hutching went from Encinitas to Ventura to study the bean growing. He brought back a German farmer, the necessary equipment and seed, and produced his first crop in 1908.

The soil and climate were found to be well suited to the crop. Lima beans were, however, not grown extensively at first. It was a new crop and unfamiliar to the farmers of the district. Further, it required specialized machinery. The farmers had equipment to handle corn culture and were naturally loath to junk it and buy new outfits. The advantage of a cash crop, a steady market, and a good price gradually worked toward the spreading of the crop. During the war prices rose and the bean farming came in to stay, and for the past 20 years has been the dominant crop of the area.

Mr. Hutching and other observers agree that at the time of introduction of lima beans, erosion was not excessive. Witnesses say that 20 years ago the valleys had free flowing streams in them, and that gullying was almost unknown. Today sheet wash, gullying, and heavy deposition of sand are taking place at a rapid rate and threaten to destroy the utility of much of the area. This excessive erosion has resulted from a combination of factors.

One of the most destructive factors has been the removal of the chapparal cover. Originally very extensive, the chapparal has been progressively cleared off. This has left little or

nothing to check the runoff from the upper slopes and remnant mesa tops. The accelerated runoff has quite naturally developed a washing and gullying tendency.

Little discretion has been used in the steepness of slope cultivated. Soils in this area become progressively shallower as one approaches the shoulder of the hill and as a general rule it can be stated that the steeper the slope the shallower the soil. In most cases there is at the shoulder of the hill but an inch or two of soil. A few years of cultivation serves to allow the soil to be swept away and a bare sandstone platform is left at the head of the field to serve as a water shed.

Soil has been lost, impoverished, and made more easily eroded by continual cropping. Humus and colloidal plant food tend to be used up and to be washed out of the soil. But since bean straw is saleable it is rarely, if ever, returned to the soil. Fallowing requires letting the land lie idle for a year, and is seldom resorted to. Rotation of crops is avoided for two reasons. The raising of any other crop allows the weeds, particularly the mustard, to reseed itself. Thus, in one year, several years of weed eradication may be wasted. Secondly, the inoculation of the soil by the nitrogen fixing bacteria is said to be lost or seriously diminished by failure to raise an annual bean crop. This loss results in a poor crop for the next 1 to 3 years and strongly discourages both rotation and fallowing. Further, due to the method of cultivation, not even a weed crop is grown which can be turned under.

Soon after the crop is removed in the fall, the land is deeply ploughed to insure penetration of the winter rains. During the winter and early spring the land is generally cultivated after each rain. This keeps the soil well worked, and kills all weeds. It also leaves the land in a most vulnerable condition for erosion. In this region the early rains are normally light and suffice to start the grass cover, but do not start washing. By the time the heavy winter rains arrive the sod is developed sufficiently to hold the soil. Bean farming prevents this and hence greatly accelerates erosion. This is aggravated in Southern California by the tendency for a large proportion of our rain to come in one storm or one series of storms so close together as to prevent sufficient drying of the fields for the farmer to work them. The soil then becomes saturated, sheet wash becomes extensive, and the rills, under continued runoff, develop into gullies.

The sequence of erosion in this area has been from sheet washing to gullying. The soils of the valley slopes apparently developed partially from gentle sheet wash which was controlled and checked by the chapparal cover. Mass movement and slumping have been of lesser importance. Today, however, the soil is being removed from the upper slopes much faster than it is being formed, while the lower slopes are being buried by sheets of sand.

Gullying apparently began later. In places the gullies have exposed cross sections of areas where the original soil was buried by several inches of sheet wash. Gullying is now progressing rapidly. In some lateral canyons they have cut as much as 15 feet deep and have nearly totally destroyed the utility of the field. Their destructiveness has gone beyond ruining the farmer's land, and gullies have begun to cut county roads, causing the abandonment of some and excessive culvert costs for others.

Heavy deposition of sandy material is extensive on the major valley floors. In some places the roads are but ruts through sand stretches which are reminiscent of auto tracks

in desert washes. The amount of wash is attested in two places by the burial this past year of barbed-wire fences to their topmost strand.

The end result has been that some fields have been completely destroyed through gullying, many fields have been damaged by burial with sand, and almost all fields in the area have been impoverished by sheet wash. Attendant on this is lowered yield, lowered income for the farmer, and lessened land value. In an attempt to overcome his lessened income the farmers of the area are clearing less productive land, and extending their fields to still steeper slopes, and areas of still shallower soil.

Some have begun to see the futility of the struggle and are casting about for a substitute crop. Citrus has invaded the area, but so far has not taken up much of the bean fields. A plan is now on foot to introduce Tung trees from China. The American consumption of the oil derived from the nut of this tree is high, the price is good, and nearly all our supply is imported. Although this particular tree may not prove to be the solution, some such a crop may be the salvation of the area.

In summary, the area stands out as a distinct area. Geologically it is that part of San Diego County which is underlain by Eocene sands. Physiographically it is that part of the Linda Vista Mesa which is most eroded. Pedologically it is an area containing much good sandy loam soils. Its utility derived from its more erosive geologic base. Its historic development has been brief. For a hundred years it has been used progressively more intensively. The introduction of the lima bean has culminated this development and has in the past 25 years so increased erosion as to threaten to destroy the utility of much of the area and to seriously damage the rest. Thus we have the anomaly of an area being developed to a point of great utility due to its erosiveness but which through lack of recognition and control of this same factor, is now rapidly being destroyed.

[1] "The Lima Bean Industry of the Southern Coastal Region." Bull. Geogr. Soc. of Phil., 1929.

The Hudson Bay Wheat Route

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The development of the Hudson Bay route as a short cut from western Canada to Europe provides a most interesting study in the geography of transportation. Strictly speaking, neither the idea nor the route is new. Several groups of Red River settlers entered the region through Hudson's Bay between 1811 and 1821. Thereafter the old trail from the Bay to Winnipeg fell into disuse except for some slight seasonal employment by Hudson's Bay Company trappers and employees.

Most of the Prairie Province wheat had reached Europe by a long triangular route through the Great Lakes to Montreal or New York, often with several transhipments enroute. The transportation charges had been high and the Prairie Province farmer grumbled about excessive shipping costs. As early as 1880 certain of the more fertile minded grumblers began to talk about a shortcut to tidewater, using the old 800-mile trail to the west side of Hudson's Bay.

The question of a Hudson's Bay railway was for many years a political football in Canadian politics. The ar-

dent demands of the West were condemned by Eastern Canada as economically unsound. The Western farmers felt that eastern opposition was an attempt by Montreal to maintain a parasitic strangle hold on Prairie Province wheat. No private railway would consider the route, but years of agitation finally resulted in the construction of a line by the Canadian National Railways at a cost of around $19,000,000. The railway was opened to traffic in 1931, and the first trial shipments of wheat went out the same year.

An analysis of the geographic factors involved, (1) in the selection of the terminus, (2) in the construction of the railway, and (3) in its function as a wheat shipping route, is the purpose of this paper. The writer spent part of the summer of 1937 at Port Churchill, and in the tributary wheat area. He is greatly indebted to various government officials for their assistance in his field work.

When the Hudson's Bay railway first became a certainty, both Port Churchill and Port Nelson were given due consideration. Port Churchill lies some 150 miles farther north than Port Nelson. Proponents of Nelson pointed out that it meant a saving of nearly 90 miles in railway construction, and that the Nelson River carries a greater volume of water and thus affords a broader anchorage and more room for future expansion. After a rather superficial examination of both sides, Nelson was selected. Surveying began in 1911, and in 1913 work got under way, continuing until 1918. By that time a number of natural difficulties had become apparent.

These unfavorable conditions at Nelson together with the shortage of ships and supplies occasioned by the World War brought the port work to a stop in 1918, after the expenditure of approximately $6,000,000. Following the war, the project lapsed for a time. The obstacles encountered at Port Nelson had somewhat dampened the enthusiasm of even the most ardent advocates of this route. In 1920, in line with the new note of caution, a special committee of the Senate was appointed to reconsider the question. This committee recommended a new and exhaustive examination of the relative merits of Nelson and Churchill.

In August, 1927, Mr. Frederick Palmer, a British engineer, visited both locations, carrying out intensive investigations. His report came to the following conclusions: (1) Nelson Harbor is exposed to the sweep of the prevailing northerly storms and has no natural protection; costly breakwaters would have to be constructed. The harbor of Churchill, on the other hand, is surrounded by rocky cliffs and provides a naturally well protected anchorage. (2) The Nelson River carries such a heavy load of sediment that the mouth of the stream is silt-choked; even by means of expensive dredging, the harbor cannot be assured of a greater depth than 28 feet at high tide. Port Churchill is not affected greatly by silting and can easily, at *any* tide, accommodate vessels drawing 30 feet of water. (3) Even adding the cost of 87 miles more of railway construction to reach Port Churchill, the total expense of making Churchill the terminus would be only about half that of a terminus at Nelson. (4) Annual charges at Churchill, including interest, operation and maintenance would be about $1,000,000 less than at Nelson. (5) Mr. Palmer strongly recommended that Churchill be made the Port-terminal.

Work was begun immediately transferring equipment and supplies from Nelson to Churchill. This was done by scow and tug during the season of navigation, and by tractor up the coast the following Spring. In no

other way could this task have been accomplished early enough to begin construction at Churchill in the season of 1928.

In relocating the railway, the most economical route to follow was found to be on the projected Port Nelson line as far as mile 356, swinging almost due north from there to the new location at Churchill. The prevailing muskeg surface over which most of this last section was laid made it necessary to construct the first grade almost entirely when the surface was frozen solid; in summer the thawed ground would not support the weight of a train. Here was a difficulty which it was thought might undo all their efforts; but the problem was shortly solved when it was discovered that a substantial gravel fill on top of the muskeg acted as a heat insulator and so prevented the foundation from giving way. This ballasting was done in short order, working from both ends and from an intermediate point, so that by Sept. 14, 1929, the track was available for use in any season.

The Churchill River drains an area nearly 1,000 miles in length, passing in its course through a number of large and small lakes. It provides an ample flow of water, though not a swift one. The length of the river and the fact that it flows through several lakes, insures a regular and constant flow of water from year to year.

The river passes into the Bay between rocky headlands. As this passage is quite narrow—no wider than would be necessary for a convenient harbor entrance—the channel is scoured to a depth of around 90 feet, thus providing as favorable a harbor approach as can be found in any of the great world ports. The harbor inside the headlands is about six miles in length and two and one-half miles across at its widest point. The low water depths in the harbor are 30 feet and above over a wide area, thus providing plenty of depth for any freighter, and ample anchorage space for as many ships as might ever assemble.

As a natural harbor and haven from storms, Churchill harbor needs no improving. No matter from what quarter the gales may rage, the rocky shores beat off even the highest seas. This is true even for a wind that blows straight through the entrance, for the harbor channel, besides being narrow, turns sharply to the south after the entrance is passed. Such waves as may possibly pass between the headlands are spent on the shores of two small bays on the west peninsula. Beyond these "spending beaches", there is practically no wave effect, and calm water is found along the eastern shore at all times.

The east peninsula was chosen as the site for the terminus. In the first place, the east side of the harbor was less exposed to storms. Secondly, the east peninsula afforded more room for the construction of terminal facilities. In the third place, a railway bridge across the Churchill River would have been a costly undertaking with no compensating advantages. The selected dock-site is approximately a mile from the entrance narrows.

Facilities for handling wheat at Churchill are quite modern and complete. The outstanding feature of the port is the two and one-half million bushel grain elevator. Embodying the latest ideas in construction and equipment, it is a beautiful example of modern reinforced concrete design.

Grain cars at the elevator are unloaded by four electro mechanical car unloaders, each capable of emptying eight cars, or about 10,500 bushels per hour. After the grain has been cleaned, weighed and elevated, it may be delivered to the wharf by a four-belt conveyor system which runs in an elevated covered gallery. There is ample room at the wharf for three

ships to load at the same time. This is done by means of spouts projecting from the conveyor system; four spouts may be discharging grain simultaneously, at the rate of 20,000 bushels per hour for each stream. Thus, wheat en route to Europe through Churchill is handled with a maximum of speed, provided ships are available.

Between the elevator and the wharf, almost in the shadow of the conveyor gallery, pens capable of holding twenty car-loads of cattle have been erected, anticipating another possible source of freight movement. To date, however, less than 1000 head of cattle have been shipped out.

The population of Churchill is about 300 during the shipping season, mainly transient. These are, in the main, elevator employees, railroad men, harbor workers, and longshoremen ,who remain onlv during the active season. The work of opening the port begins about the middle of June, although the actual shipping season does not open until the 10th of August. The season closes Oct. 10th, and most of the transient population is gone before November 1. Those in the permanent settlement group of some 75 people are Hudson's Bay Company employees, the Mounted Police, an upkeep crew, and a scattering of Chippewyan Indians and trappers.

Comparative cost between the ports of Vancouver, Churchill and Montreal is the limiting factor of the Churchill hinterland. This tributary area is entirely within the province of Saskatchewan; roughly, goods north of an imaginary line drawn between North Battleford on the west and Yorkton on the east, may be sent more cheaply through Churchill than through either Vancouver or Montreal.

The hinterland of Churchill is today the heart of Western Canada's world-renowned Spring Wheat belt. The area assumes significance if we realize that the province of Saskatchewan in 1935 produced 132 million of the entire Canadian production of 250 million bushels. In view of the recent decline of wheat prices on the world market, there has been a tendency in the last few years toward diversification of production. Oats, barley, livestock and dairying are increasing in importance.

As the railway stretches northward from the wheat region, it passes through increasingly wild northern coniferous forests. These forests produce a small amount of lumber as a pay-load for the railway, the industry centering in the Pas, Manitoba, some 300 miles north of the wheat belt. Near the Pas, at Flin Flon, and again at the Sherritt-Gordon mines, an increasingly rich yield of gold, silver, lead, animony and zinc is being produced. None of this has moved north, however, so with the exception of the import of a small amount of machinery, this industry has not affected the Hudson's Bay route.

Beyond the Pas, the area is one of stubby, poorly nourished conifers, merging to the north into muskeg swamps and finally, some fifteen miles south of Churchill, becoming pure tundra. Five hundred miles from the Pas, and over eight hundred from the wheat belt, the railway arrives in Churchill. The route from here is northeast across Hudson's Bay, through Hudson's Strait, and across the Atlantic to Europe.

The water route to date has provided the greatest geographical obstacle to the success of this northern port. There are three hazards to be overcome. The first and most important of these is *ice*. Though Hudson's Bay itself is relatively free from floes between May and November, ice drifting from the north down Foxe Channel obstructs Hudson's Strait for all but two months of the year, August and September.

A second major difficulty is *compass trouble.* Because of the proximity of the magnetic pole, an ordinary compass is nearly useless; however, this difficulty is being overcome by the nearly universal use of the gyroscope compass.

The third obstacle to shipping is *recurrent fog.* This, in view of the presence of possible drifting ice, is a source of constant danger and may cause considerable delay.

The Dominion government is sparing neither trouble nor expense to reduce the hazards on the route. Radio direction finding stations, superior weather forecasting, ice-breakers, and powerful patrol steamers are some of the modern aids to northern navigation. Radio reports on ice conditions are a feature of this work. This valuable government service has tended toward the gradual reduction of insurance rates, although they are considerably above those in Montreal or Vancouver.

The outstanding advantage of the Churchill route is, of course, the tremendous saving in distance between the wheat belt and the European market. It was around this single salient fact that the proponents of the route based their case, and it was this argument that finally overcame resistance to the project. Taking Saskatoon as a focal point for Prairie wheat, a comparison shows that a saving in distance to Liverpool is effected through Churchill of 971 miles over Montreal, and 5,572 miles over Vancouver. Moreover, there is a considerable saving of distance to tidewater on the Hudson's Bay route.

Since Churchill began operations in 1931, approximately 17½ million bushels of wheat have been exported. The amount has varied from 545,000 bushels in 1931 to 4,293,000 bushels in 1936, the heaviest year. In addition to this wheat, small amounts of other commodities such as lumber, cattle, flour, and honey have been exported.

Imports have amounted to almost nothing. A few hundred tons of manufactured goods from the factories of Europe, such as agricultural machinery, binder twine, glass, barbed wire, etc., have come in. Most of the ships have come in under ballast, however. This lack of imports has prevented any substantial reduction in freight rates, for the expenses of the trip must all be made from the return cargoes to Europe.

The place of the Hudson's Bay route in the Canadian wheat export picture appears on the surface to be negligible. Of the several hundred million bushels of wheat exported from Canada since 1931, only a small fraction has gone through Churchill. However, the effect has been deeper than appears on the trade records. It has been estimated that the very presence of Churchill as a threat to the Montreal and Vancouver routes has brought down rates over these routes by one to three cents per bushel. In this somewhat intangible way, then, Churchill has to an appreciable extent alleviated the transportation difficulties of the Prairie farmer.

The main thing in developing a new port is to furnish cargoes in any demanded quantity. Before this can be achieved at Churchill there are certain abstacles to be overcome, and certain improvements to be made.

1. The limitation imposed by climate and ice is one of extreme importance, causing a difficult shipping hazard and high insurance rates. Improved safeguards have reduced insurance rates somewhat but the season is still too short to accommodate any great volume of shipping.

2. The lack of inbound cargo is an obstacle to low rates. Most of the wheat export steamers are obliged to arrive empty, since there is little demand for imports over this route. The difficulty is in meeting the demand

for agricultural machinery and appliances when the need arises. Should the shipping season not coincide with the harvest, the goods imported would have but minor value. As the timely arrival of goods cannot be guaranteed, their main flow is through other ports.

3. Trading facilities do not exist at Churchill. There is no such thing as a "Churchill price." Wheat in store is not in a position to be delivered against a futures contract. With hedging thus prevented, considerable financial risks of market fluctuations are involved in developing Hudson's Bay grain exports. Because of this, the pioneer development of this port may be undertaken only by large organizations able to face the risk, and, if necessary, absorb certain losses in the interests of the project. This difficulty, again, hinges on the shortness of the shipping season.

4. Due both to the uncertainty of chartering ships and the shortness of the season, wheat arriving in Churchill may miss the last steamer, necessitating storage in the elevator until the following summer. The danger of loss of interest on the capital involved prevents a good deal of "eligible" wheat from being shipped through Churchill.

5. It is necessary in the early stages of this port, that rates through Churchill be several cents lower than either the Montreal or Vancouver routes. Shippers are unfamiliar with the route, and generally skeptical as to its value. If more wheat brokers were given opportunity to assure themselves of the safety and economic advantage of the route, it is possible that trade would increase substantially.

The various problems to be faced are inseparably inter-related with one another. Any extension of the shipping season would mean more ships and increased imports at Churchill; more ships sailing in and out of Hudson's Bay without loss will lower insurance rates, which in turn would reduce freight rates and further increase the intensiveness of the trade. Also, the longer the season, the greater the possibility of developing a futures trade through Churchill. Any extension of the season will be necessarily small, however, so that the solution of these problems will probably never be complete.

Although hindered by the geographic factor of climate from developing into a large scale port comparable to those in more favorable environments, the Hudson's Bay route through Port Churchill should not be listed as a failure. Falling short of the too-optimistic visions of its early proponents, it nevertheless should assume a modest but definite role as an outport for the farmer of Western Canada.

Water Planning in the Great Central Valley, California

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The Central Valley Project now under construction in California is the greatest water development project ever undertaken in a region of Mediterranean climate. The project is the culmination of 87 years of attempts to solve the water problems of the Great Central Valley of California.

The Great Valley, with an area exceeding that of the three southern New England States, larger than any Mediterranean lowland of the Old World, contains more than half the cultivated land of California. In the

census year 1929, 3,640,000 acres were harvested in the valley. The valley floor includes 8 million acres in the San Joaquin Valley, in the south, 3½ million acres in the Sacramento Valley, in the north, and ½ million acres in the centrally-located delta.

Regional and seasonal inequalities in available water create the major problems of the valley. With two-thirds of the total area, the San Joaquin Valley receives but one-third of the annual stream runoff of the Great Valley. Furthermore, precipitation decreases steadily southward, with annual rainfall only 15 per cent as great in the southern as in the northern end of the Great Valley. The western margin, in the rain shadow of the Coast Ranges, receives one-third less rainfall than the eastern, and stream-runoff along the entire western valley margin represents only 6½ per cent of the total drainage into the valley. The San Joaquin Valley is largely a hot desert (BWh of Koppen), with a fringe of steppe; the Sacramento Valley has a hot summer Mediterranean climate (Csa); and the Delta, due to summer oceanic winds pouring through the break in the central Coast Ranges, has the cool summer Mediterranean type of climate (Csb). The regional water problem of the valley is to transfer water from the humid north and east towards the dryer south and west.

The seasonal water problem of the valley arises from the Mediterranean type of rainfall regime, with wet winters and dry summers, and floods in winter and spring, shortage of precipitation and of stream water in summer and fall. Most summer crops require irrigation in such a climate, and local supplies of irrigation water are inadequate even for existing cultivated lands in some areas, notably in the southeastern part of the San Joaquin Valley, where the water table has been lowered by pumping trom wells. The shrinkage of stream volume hampers navigation upon the Sacramento River in summer, and permits salt water from San Francisco Bay to back up into the channels of the Delta, seriously restricting the irrigation of crops which depend upon water taken from Delta channels and making it necessary for factories near Carquinez Straits to send barges far afield for fresh water for industrial purposes.

Hndered by geographical unsuitable laws of riparian rights based upon English common law adopted by the first state legislature in 1850, water development of the Great Valley has been carried on largely by uncorrelated activities of local private and political agencies, especially by cooperative irrigation ditsricts which include half the irrigated land of the Valley. Water is obtained by direct gravity diversion from streams, pumping from streams, dams in the Sierra

ORIENTATION MAP

Nevada and Coast Ranges, and pumping from wells.

The first tentative plan for coordinated development of water resources of the Great Valley was drawn up in 1873 by a committee of the War Department, including George Davidson, first chairman of the Department of Geography of the University of California. This plan envisioned canals taking out from the Sacramento River near the northern end of the Valley and running southward along both valley margins, to irrigate the northwestern, northeastern, and southeastern quadrants of the Great Valley. Across each river emerging from the Sierra Nevada, dams were to be built, articulated with the east side canal. The dryest, southwestern quadrant was to be irrigated in part by means of a canal conducting water northward from Tulare Lake (then a considerable body of water) to the Delta.

In 1919 an unofficial plan, outlined by the geographer, Robert Marshall, began to catch the imagination of the people of California, and led to legislative appropriations for a thorough study of water problems and the drawing up of an official engineering plan for coordinated water development. The Marshall Plan contemplated a series of Grand Canals completely encircling the Valley, carrying water from the wet northeast towards the dry southwest; and a dam across Carquinez Straits (outlet of the Sacramento-San Joaquin Rivers) to exclude salt water from the Delta.

The Central Valley Project, 170-million-dollar plan adopted by the legislature and confirmed by a popular referendum in 1933, differed considerably from previously-proposed plans. The ideas of a complete valley-rim canal and of a salt water barrier were excluded. The Project includes a dam on the San Joaquin River in the foothills at Friant, with a storage capacity of 450,000 acre-feet, and with canals leading from it along the foothills for 210 miles, to replenish the ground water of the southeastern San Joaquin Valley; a series of dams and pumps across the lower San Joaquin River south of Stockton, to transfer water southward from the Sacramento River surplus to replace the water diverted in the upper San Joaquin River by the Friant Dam; a 560-foot dam (Shasta Dam), key unit of the entire Project, in the Sacramento River Canyon near Kennett, with a capacity of 4,500,000 acre-feet, for storing surplus winter water to reduce floods in the rainy season and to fill the Sacramento River channel in the dry season, thereby improving navigation, furnishing surplus water for the lower San Joaquin River, and keeping enough fresh water in the river to prevent encroachment of salt water from the Bay; a hydroelectric plant at Shasta Dam, with generating capacity of 350,000 kilowatts, calculated to provide about half the revenue of the Project when completed; an electrical transmission line to run 200 miles from Shasta Dam to the Delta, with an extension to provide power for the San Joaquin River pumping system; and an aqueduct in the Delta in Contra Costa County to transmit water from the Sacramento River to factories and small farming areas near Carquinez Straits.

Although the Central Valley Project, now being built with federal funds under the United States Bureau of Reclamation, is an outstanding example of regional planning by a single state, it is only a part of a comprehensive California State Water plan drawn up under the direction of the State Engineer. This ultimate State Water Plan includes development of Colorado River water for Southern California (a project now nearing completion), diversion of Trinity River water to the Sacramento River, construction of storage

dams on all important Sierra Nevada rivers, and transportation of water by canal around the southern end of San Joaquin Valley from east to west. The estimated cost of ultimate major units of the State Water Plan in the Great Central Valley alone is $683,900,000. The Plan will probably be adopted piece by piece as demand justifies.

The Papago Villages of Arizona and Sonora; Types and Sites

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The Papago are a tribe of Indians numbering about 6000, who occupy the desert area along the Mexican boundary in south central Arizona. In this isolated desert environment, the Papago has been peculiarly immune from aggression. So the basic pattern of geographic adjustment has remained much the same, yet we may recognize four periods. The first was prehistoric, antedating the appearance of the white man, and therefore a phase of the maize and squash cultural complex common to the Southwest. In the second period of adjustment, that of Spanish influence, Catholicism, livestock and wheat were introduced. The third period dated from the Gadsen purchase. Americans came to open mines and to establish stock ranches especially in the late sixties and seventies. The fourth period, within the present century, is a continuation of American influence. Hitherto American influence was passive, now it has become active in the stimulation of Americanization processes.

The village of Pacinimo may be taken as expressing the general average of Papago villages. The Indian population numbers 171, and the white population 12. Two main groups of adobe and wattle houses or huts are at the north end of the village and represent two families, in the sense only that the people are all inter-related. At the south end of the village is the Catholic chapel and school, a small trading post, and a few Indian houses. Between the north and south ends of the village is the government well with the wind-mill and storage tanks. A large charco for the catchment and storage of surface runoff skirts the southeast edge of the village.. There is no other structural arrangement and nothing even suggesting streets. The site of Pacinimo is typical of villages and settlements dependent upon fields, located where the lower bahada and creosote bush zone gives way to the valley flats with salt bush and mesquite. Here the washes emerge from the arroyos and the water may be spread over the flats.

Two types of village sites developed in earlier times; those located with reference to tillable plots. The former were reserve villages located at the foot of mountains or in their foothills. In late years deep wells have been put at nearly all the villages located at the fields, and so the reserve villages have shrunk, but in most cases a few families remain to take care of cattle.

There are no large well built prehistoric structures in the Papago country, such as the Casa Grande on the Gila and the Pueblo ruins in the Salt River valley. However there are a number of fortified hills, with defense walls and rock terraces which were used for house sites. Excepting as the houses were partly walled up, their construction, as today, was very ephemeral. Such sites, known as "trincheras de cerros" are most numerous in the valleys of northern Sonora. Six such fortified hills are known in the

southeastern more favored part of the Arizona Papago reservation. Their builders were certainly on the defensive. Were they a prehistoric people driven out by invading tribes of Piman stock, or were they ancestors to the present Papago, harassed for a time by invaders whom they successfully resisted or assimilated? If the Papago are descendent from the Hohokam, or canal builders of the Salt and Gila plains, then the trincheras must be regarded as prehistoric Papago settlements. The invaders may have been Pueblo people from the north, the Salada people of Gladwin and Haury, or possibly they were the product of early Apache invasion.

Soil Conservation Instruction in Common Schools and Colleges

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Educators have long recognized the fact that grade school training may play a vital part in determining a student's outlook upon additional years of school work. Even kindergarten nature study trails can well be the beginning of a lasting interest in conservation. Along with the customary bird and animal love developed, should be the teaching of saving the soil and water that makes life possible for the youngsters' feathered friend or pet. To the young student of 8 to 12 such points as the following are definitely worthy of note: (1) The cutting away of the stream banks of tiny seasonal rivulets or large rivers, (2) Erosion of roadside cuts, (3) Coloration of streams during periods of excessive runoff, (4) The color of the water running from fields protected by vegetation as contrasted with the run-off from unprotected fields, (5) The luxuriant growth of plants in deep, fertile soil as contrasted to the stunted condition of plants in thin, rocky soil.

Such features of the soil conservation phase of general conservation can and should be definitely tied in with work in developing a regard for conservation of wild life, forests, minerals, water, and human resources of each locality and the nation at large. Thus the child visions soil conservation as a necessary part of the entire problem of conservation rather than something set apart.

Upon reaching the upper grade level the student is ready for experimental and demonstrational assignments to follow through to practical usage the concepts gained from observations and discussions in the lower grades. It is here at the adolescent age that the student should be also introduced to regular textbook study. A survey of soil erosion damage in the different sections of the U. S. and in other parts of the world is vital.

Social or general science classes in the junior high age group afford excellent opportunity to include a study of "things as they ought to be." With the wealth of material now available in government bulletins and in popular magazines, units on each of the six phases of conservation might well take from ten to twenty periods each. There will be a tendency to vary the emphasis with each locality, that is, in a lumbering community forest conservation will be of paramount importance. It must be noted, however, that soil and water are basic and that their conservation should form the key or nucleus around which other conservation study must center.

The extent of senior high soil conservation instruction will depend upon the amount of work done in the junior high grades. There should be at least

a one semester course in the four years of high school in addition to a tie-in with other subjects whenever the occasion arises. It seems that such repeated instruction and philosophies of saving natural and human resources are more satisfactory than one lengthy course. Such a course should build up an appreciation for, and a sense of conservation of, resources which will be carried into everyday life by those not going on to college. It should also serve as an introduction to further conservation study in colleges and universities.

College and university conservation instruction may be planned to care for three general groups of students. The first group includes students in law, medicine, liberal arts, and technical subjects not directly concerned with conservation, but who need a general knowledge of the subject so that those who may later become civic leaders may have a realization of conservation problems. The second group to be considered includes those students desiring to train for work in the field of erosion control, and if the demand warrants, also as specialists in conservation. The third group consists of those studying to become teachers in our common schools and colleges. Every teacher in the classrooms of the American schools should be required to take a basic conservation course. The primary objectives of a course given all teachers may be, first, inspiration, and second, general knowledge. Yet the courses taken by those expecting to teach conservation must also include much detailed information, suggested methods of presentation, and sources of all types of teaching aids.

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Geomorphology from Detailed Geologic Mapping, Western San Gabriel Mountains

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A detailed geologic study of a section* across the western San Gabriel Mountains, Los Angeles County, California, was used to reconstruct the morphologic history of the range. Methods of investigation included detailed geologic mapping on a scale of one inch to 1,500 feet, lithologic studies involving pebble counts, examination of mineral grains and rock thin-sections, and collection and determination of fossils.

Two great generations of igneous intrusions indicate orogenic periods in the Late Paleozoic and Upper Jurassic. Following the second mountain-building erosion reduced the region to low elevation and the seas advanced in the Lower Eocene (Martinez) epoch to end the history of the ancestral San Gabriel Mountains.

In the history of the modern San Gabriel Mountains five major cycles of erosion are recognized. The first great erosion interval followed the initial folding and uplift of the region in post-Martinez time and reduced the land surface to old age by the Middle Miocene. The only recognizable remaining physiographic forms of this interval are certain features of the drainage pattern. The second erosion interval was initiated by uplift and southward-tilting of the San Gabriel block in the Middle Miocene, bounded by north-side faults. Renewed elevation along the same faults rejuvenated the area in Late Pliocene time. Traces of the mature land surface developed in this third erosion interval are recognizable. About Middle Pleistocene (post-Saugus) time

the western San Gabriels were intensely folded, faulted and elevated at least 4,000 feet in the greatest orogenic period that region has suffered in post-Jurassic time. The ensuing fourth period of erosion in the Upper Pleistocene brought the greater part of the range to early maturity; the present, steep, rugged, deeply dissected land surface forming principally in that interval. The fifth and last cycle, in the Recent spoch, has been complicated by rejuvenation due to vertical uplift at least three times resulting in the formation of prominent terraces and youthful inner gorges cut within the older more mature valleys.

Present physiographic features are complex, reflecting the history of the region through five interrupted erosion cycles, but with most land forms of post-Lower Pleistocene age. Folding, faulting and distribution of rock types have played important roles in the topographic forms developed but the extent and direction of the periodic uplifts has been of greatest importance in the drainage pattern and resultant land forms.

* For an account of the rock formations and structure the reader is referred to the author's paper titled **Geology and Mineral Deposits of the Western San Gabriel Mountains, Los Angeles County, California.** Calif. Jour. Mines and Geol., **State** Div. of Mines, July 1937, pp. 215-249.

The Geographic Setting of the Middle Rio Verde Valley

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The middle Rio Verde Valley is an enclosed structural basin in central Arizona. Isolated by the sheer cliffs of the Colorado Plateau to the north and east, and by the steep faulted face of the Black Hills to the west and south, the region is a distinct geographic unit, differing markedly in surface features and climate from the neighboring areas. The Rio Verde has cut tortuous canyons through lava formations at both the upper and lower ends of the Basin. The enclosed area considered in this study contains approximately 600 square miles.

This structural basin formed near the end of the Mesozoic period of geologic history, became the depository for sediments washed in from the surrounding highlands. A lava dam across the lower end of the basin created an inland lake in which deposits accumulated to a thickness of 2000 feet. A few lava capped islands protruded above the sea. Headward erosion, overflow of the lake, or faulting lowered the outlet and permitted the drainage of the basin. Since the draining of the lake the lacustrine deposits have been eroded into mesas, terraces and valleys. Wash deposits have been dropped by flood waters along the margins of the basin and along the stream courses.

The enclosed basin area, at least 3000 feet lower than the surrounding highlands, experiences an arid climate. Middle latitude, continental location in the lea of mountains insures temperature seasonality and meager rainfall. Less than thirteen inches of precipitation, high summer temperatures, low relative humidity, brilliant sunshine, but rather cool winters place the region in a BSk climate according to the Koeppen system of climate classification. The average temperature and rainfall figures make it very close to the margin of the hot desert climate of North America.

The Rio Verde and its permanent tributaries are fed by springs whose sources lie in the more humid higher borderlands. Porous lava caps on the mountains and plateau act as huge sponges which conserve and regulate

the flow of water. Gravel beds within the lake formations also serve as storage reservoirs for ground water and add to the water available to the basin.

Rich copper ores found in the Black Hills have made the section famous as the sixth ranking copper producing region in the United States. Sand, clay, limestone, gravel and sodium sulphate supplement the chief mineral resource and have played important roles in the life of the inhabitants.

Soil resources are limited to small patches of recent alluvium along the streams and few level areas on stream terraces.

The most striking feature of the native plant life is its adaption to arid conditions. This region includes a poor forest land above 4000 feet elevation. Juniper and pinon pine, widely spaced, give the appearance of a dwarfed orchard and represent the desert margins of the pine forests of the plateau and mauntains. Shrubland occupies most of the Verde Basin with a sparse covering of creosote bush, mesquite, palo verde and sage. A stand of black gramma grass clothed the lower terraces when white settlers first came to the Valley.

White settlement has wrought two significant changes in the Middle Verde environment. Over-grazing accelerated erosion and, after seventy year's occupation, large areas are barren wastelands where cattle once grazed and ranchers harvested wild hay. Sulphurous smoke issuing from smelter stacks has added certain elements to the atmosphere in sufficient quantities to be detrimental to plant life.

The Middle Rio Verde environment, isolated by physical barriers which still challenge the mechanical ingenuity of man, in an arid climate with limited resources of soil, water, vegetation and animal life but rich in available deposits of copper, furnishes an ideal laboratory to the geographer to study the adjustments made by man to this geographic setting during a long occupation by several stages of culture.

Chicago: A Study in Urban Geography

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Three centuries ago the population of the United States was very largely rural, and was confined to the east side of the Appalachian Barrier. The Treaty of Paris, in 1763, removed the French wedge of forts from the valleys of the Ohio and the Mississippi rivers, and was an important factor in the westward movement. Although our population numbered 23,000,000 at the middle of the nineteenth century, large cities were few.

In 1820 New York was the only city in the United States having a population of 100,000 or more. In 1930 there were approximately 100 such cities, and 26 per cent of our total population lived in them. In 1800 only four per cent of our people were classed as urban, but in 1930 the urban population was 49.1 per cent of the total. Our schools give insufficient attention to the study of urban geography.

A city should not be presented as an isolated unit, but rather in its relations to its hinterland. Site, position, climate, transportation, and man's utilization of and changes in geographic environment, are among the topics to be considered.

A favorable site, position in a region of unusually rich and varied resources, adequate transportation facilities, and wise and energetic human responses have, in less than 150 years, given Chicago a place as one of the chief cities in the world.